Modelling the contribution of natural capital to the wider economy

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Outline

- Policy
- Economy-wide models at FAI
- NC/ESS additions to such a model e.g.
  - Agriculture Provisioning
  - Recreation
- Conceptual difficulties
- Project plans

Policy

- Policy of "Sustainable economic growth"
- Given environmental inputs to production and environmental goods that we all enjoy, impossible to consider economy to be sustainable if we do not monitor state of the environment
- Added salience with policy profile of climate change
- But quantitative impacts of policy advice typically only GDP and employment
- Environmental impacts evaluated separately or not at all (and certainly not with same framework)
- Need to link...

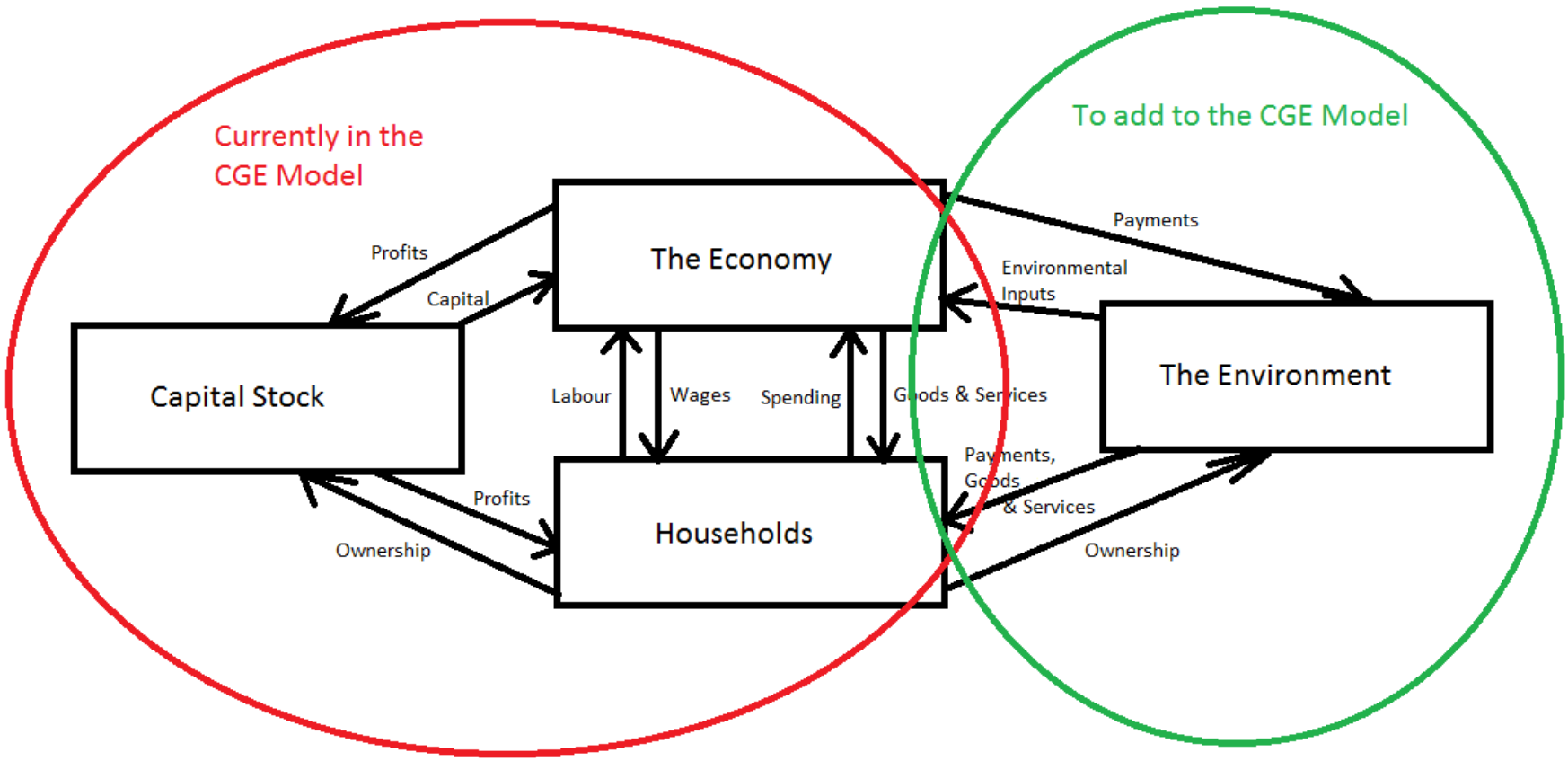
Economy-wide models at FAI

- At FAI we have Computable General Equilibrium (CGE) Models
- Computable: many industrial sectors, possibly disaggregate workers by skills and households by income, multiple regions $\Rightarrow$ complex, compute numerical solution
- General Eq: firms maximise profits, consumers maximise utility, and all markets clear (subject to frictions) $\Rightarrow$ price (of any good) equals its marginal product (as input into all processes) equals its marginal utility (for all consumers)
- Used to analyse GDP and employment impacts of policy, projects, and other shocks
- Have been applied to environmental and energy applications e.g. Green jobs, Impact of offshore wind; but not with NC or ESS

Economy-wide models at FAI

- Modelling stages
  - Model specification
  - CGE models calibrated to IO data
  - CGE model replicates data in base
  - Then exogenous change can be made and analysed e.g. tax change, efficiency change in a sector, foreign demand shock etc
- Difference between CGE and IO frameworks: IO is a CGE with entirely passive supply side and no prices

Economy-wide models at FAI



Natural capital/Ecosystem services

- E.g. ONS produce Natural Capital accounts
- The value of an ecosystem service flow is calculated for:
  - "Provisioning Services", based on market value of the output produced with these inputs (i.e. already in GDP)
  - "Regulating Services", based on the costs that would be incurred if this service was not provided (i.e. not in GDP)
  - "Cultural Services", based on non-market valuation techniques (i.e. not in GDP)
- Value of NC stock = PV of ESS flow projected into the future

Natural capital/Ecosystem services

Natural Capital Monetary Estimates - Flow Values, £ million, 2014 Prices, 2007 - 2014									
	2006 (£m)	2007 (£m)	2008 (£m)	2009 (£m)	2010 (£m)	2011 (£m)	2012 (£m)	2013 (£m)	2014 (£m)
Provisioning Services									
Agriculture[1]		233.7	1,546.6	0.0	1,293.2	1,073.3	1,154.1	1,753.4	1,322.8
Fishing And Aquaculture[1]		353.9	315.0	327.8	457.1	353.9	347.0	322.6	384.0
Timber[1]		132.7	89.3	95.1	146.5	160.0	149.0	185.4	225.2
Water[1]		1,215.6	1,431.8	777.5	692.4	1,127.0	1,430.0	1,504.0	1,203.0
Mineral[2]		91.4	166.2	220.4	111.9	249.3	318.5	230.8	213.6
Oil and Gas[3]		17,466.0	26,007.7	19,349.8	20,023.6	24,495.7	18,116.0	14,210.4	7,106.0
Wind[4, 8]					552.0	2787.0	1941.1	2111.7	1837.1
Hydropower[4, 8]					453.4	533.6	241.6	327.0	311.8
Regulating Services									
Carbon Sequestration[5]		1,411.7	1,423.4	1,455.6	1,570.1	1,606.2	1,630.0	1,645.2	1,665.0
Pollution Removal[6]	5,006.5						4,505.2		
Cultural Services									
Recreation[7]				7,889.0	8,432.0	7,860.0	8,080.0	6,562.0	6,520.0

Agriculture Provisioning

- Provisioning service. Used to produce agricultural output that's already counted in GDP
- ONS (2016): 16% of profits from Agriculture can be attributed to services provided by natural assets
- Create new Env sector which supplies ESS to Ag. Profits in Ag down 16%, profits now appear in Env (ultimate ownership of profits unaffected)
- Extend production function:
  $x_A(K_A, L_A, I_{1A}, ..., I_{nA}, I_{MA}) \rightarrow x_A(K_A, L_A, E_A, I_{1A}, ..., I_{nA}, I_{MA})$
- $E_A \equiv$ real input, $P_E E_A = 16\%$ Ag profits, $P_E = P_A \frac{\partial x_A}{\partial E_A}$
- This can be done. Issue: real vs nominal quantities
  - Fall in price of Ag output $\Rightarrow$ fall in price and hence value of ESS despite real quantity unchanged
  - Environmental shock $\Rightarrow$ fall in real quantity of ESS input but depending on price response, f(substitutability), nominal value of ESS & NC can go up or down

Recreation

- Cultural service. Population values it, but doesn't pay for it e.g. landscape in national parks
- Estimate the ESS flow value and hence NC stock value using non-market valuation techniques
- Again imagine Env sector which charges for consumers to enjoy these goods, and distributes its profits back to consumers, so that budget constraints are satisfied
- These expenditures would imply an environmentally augmented GDP $>$ currently reported GDP
- Consumers choose spending to maximise utility $\Rightarrow$ infinite demand for any free good in utility
- Need finite quantity consumed at positive price derive from notional expenditure using extended utility function: substitutability?, price elasticity of demand for these goods? Highly uncertain, in principle can be done.
  - Then value affected, through price, by income shocks
  - Environmental shock $\Rightarrow$ Δreal quantity of ESS, but price changes mean Δnominal value of ESS & NC can go either way

Project Plans

- Case study 1: impact on economy and emissions of change in food demands (reduction in red meat consumption)
  - Important to include carbon sequestration services provided by agricultural land
  - Also interesting to see to what extent results are affected by inclusion of Agriculture Provisioning services
- Building modelling capacity - in general how does the addition of environmental goods and factors affect the model's results? And how do the standard scenarios that we explore affect real and nominal values of NC stocks?
- What should our next case study be? E.g.
  - Simultaneously examine the economic and environmental impacts of adopting some of the technologies discussed in Eory et al (2016) "On-farm technologies for the reduction of greenhouse gas emissions in Scotland"
  - Simultaneously examine the economic and environmental impacts of CAP replacements

Thank you

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